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**SUSTAINING NAVAL SURFACE COMBATANT VERTICAL LAUNCH
SYSTEM MUNITIONS DURING JOINT OPERATIONS**

Michael E. Moore
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**SUSTAINING NAVAL SURFACE COMBATANT VERTICAL LAUNCH
SYSTEM MUNITIONS DURING JOINT OPERATIONS**

by

Michael E. Moore

Commander, Supply Corps, United States Navy

A paper submitted to the Faculty of the Joint Advanced Warfighting School in partial satisfaction of the requirements of a Master of Science Degree in Joint Campaign Planning and Strategy. The contents of this paper reflect my own personal views and are not necessarily endorsed by the Joint Forces Staff College or the Department of Defense.

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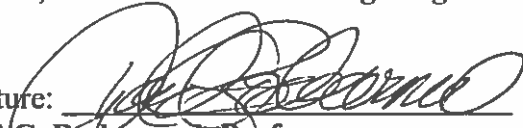
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ABSTRACT

Maintaining maritime dominance against near peer adversaries will tax an already complex logistics structure that depends upon freedom of movement to deliver critical materiel required to sustain operations. While the U.S. Navy is proficient in delivering fuel and other materiel via underway replenishment, it also depends heavily upon a network of airports and seaports. The Combat Logistics Force, operating from these facilities, carries this materiel and moves it the last tactical mile; however, the Mark 41 Vertical Launch System (VLS) represents a critical vulnerability as it can only be reloaded while a ship is in port. Additionally, the Navy relies heavily upon access to port facilities that are often in range of potential adversaries possessing anti-access and area denial weaponry. Protecting this infrastructure and sustaining naval operations requires the cooperation of the other Services to provide air defense, force protection, and just-in-time delivery of munitions via inter-theater air transport. A review of naval operations in the 20th Century reveals operational insights and specific requirements for addressing MK 41 VLS replenishment in austere ports and anchorages. To minimize the burden on the Services for transportation and force protection and to gain increased agility in conducting prolonged combat operations at sea, the Navy should develop a balanced logistics and auxiliary tender force.

DEDICATION

I dedicate this thesis to my wife and children. Thank you for your support over the last year.

To my mentors, Captain James Poe and Captain James Shields, thank you for the counsel you have provided me over the course of my career.

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LIST OF ABBREVIATIONS

A2/AD	Anti-Access/Area Denial
ASCM	Anti-ship Cruise Missile
CIWS	Close In Weapons System
CLF	Combat Logistics Force
CRG	Contingency Response Group
ESSM	Evolved Sea Sparrow Missile
ISR	Intelligence, Surveillance, and Reconnaissance
PLA	Peoples' Liberation Army
PLAAF	Peoples' Liberation Army Air Force
PLAN	Peoples' Liberation Army Navy
QRT	Quick Response Team
SM-2	Standard Missile
UNREP	Underway Replenishment
U.S.	United States
USN	U.S. Navy
VLA	Vertical Launch Anti-submarine Rocket
VLS	Vertical Launch System

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Introduction

The Peoples Liberation Army Navy (PLAN) and Peoples Liberation Army Air Force (PLAAF) have the ability to overwhelm U.S. Navy (USN) carrier strike groups with anti-ship cruise missiles (ASCMs), causing surface combatants to expend large numbers of surface-to-air missiles, depleting their defensive munitions.¹ Several other near peer adversaries possess similar Anti-Access/Area Denial (A2/AD) capabilities to contest United States (U.S.) military operations.

A Navy carrier strike group has the ability to defeat an initial attack but a significant expenditure of missiles, fired from the MK 41 Vertical Launch System (VLS), would diminish its capacity to withstand repeated attacks. The MK 41 VLS limiting factor is its reloading process, which requires the ship to be stable with minimal pitch, roll, and yaw. These conditions rarely occur in the open ocean. Lacking the ability to replenish VLS munitions at sea, a Navy carrier strike group would have to return to port in order to rearm its VLS missiles. During a conflict, the port in which rearming is conducted would require protection from adversary attack. In the event of conflict with a near peer adversary possessing weapons capable of striking the reloading port, the Navy may not be able to conduct VLS reloading at preferred port facilities due to threat of attack or actual damage to key facilities. The Navy may have to withdraw to another port outside the range of likely enemy attack in order to rearm its VLS equipped ships. Unfortunately, withdrawing from the battlespace risks ceding initiative to the adversary, which will slow the tempo of combat operations and present risk for the Combatant

¹ Dennis M. Gormley, Andrew S. Erickson, and Jingdong Yuan, *A Low-Visibility Force Multiplier, Assessing China's Cruise Missile Ambitions*, (Washington, D.C.: National Defense University Press, 2014), 77.

Commander. The Navy must have a means to conduct VLS re-arming operations away from its primary ports in order to conduct extended combat operations.

Presently, the Navy has no means to replenish the MK 41 VLS at sea. It conducts all loading operations in port. A VLS loading operation requires a crane and specially trained Quick Response Team (QRT) that load the missiles. When the operational tempo requires reloading operations to be conducted for deployed ships, the QRT, and missiles required for rearming are flown to a port facility in close proximity to an airfield capable of landing a large transport aircraft.² The crane required to support the operation either is obtained at the loading port or is flown in with the QRT and missiles. Finally, depending on the capabilities of the destination airport, a U.S. Air Force Contingency Response Group (CRG) may need to accompany the QRT to unload the missiles from the transport aircraft and deliver them to the loading port.

Viewed superficially, one may conclude that this is solely a naval problem. In fact, the impact is much larger as it affects planning for access, materiel movement, operational maneuver, tactical employment, and sustainment. The present operational paradigm for reloading VLS munitions away from an established naval base requires the movement of a QRT and missiles, and often a CRG via air to an airfield located in close proximity to a port. This time consuming process requires coordination across services and functional and geographic combatant commands. The current inability to replenish VLS munitions at sea or in austere forward locations reveals a larger problem in the number and types of vessels that comprise the Combat Logistics Force (CLF).

² Typically, C-17 and C-5 aircraft are used to transport VLS munitions. The quantity of munitions carried is limited by the net explosive weight limitation of the aerial port of embarkation and the aerial port of debarkation.

A hypothetical vignette, described in the next section illustrates the shortcomings in the MK 41 VLS and constraints imposed on a naval force after a battle.

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Hypothetical Vignette

A Navy carrier strike group, consisting of a carrier, one cruiser, two destroyers, and a fast replenishment ship transits through the Philippine Sea to take station in the South China Sea between the Philippines and China. The U.S., China, and the Philippines are at increased tension after a Philippine naval vessel exchanged fire with two Chinese warships over contested fishing waters. The PLAN warships damaged the Philippine vessel, which is now limping to Subic Bay. China has threatened to attack the U.S. if it attempts to intervene in this incident.

The strike group commander's morning update brief noted that satellite imagery obtained over the last 24 hours showed Chinese People's Liberation Army (PLA) units based on artificial islands in the South China Sea moving missiles from storage to firing positions. Chinese drones are also shadowing the USN strike group. PLAN surface units and at least one anti-ship cruise missile (ASCM) armed submarine are operating along the strike group's intended movement path. Intelligence reports also indicate that the PLAAF prepared one regiment of H-6K long-range bombers, capable of carrying anti-ship missiles, for a likely mission in the Philippine Sea.

Three hours after the strike group commanders' morning update brief, the Air Defense Coordinator onboard the cruiser reports radar contact with approximately 80 inbound missiles. The strike group's combat air patrols, however, are not in position to attempt an intercept on the incoming missiles. The strike group's escorts, the cruiser and two destroyers, are the only means of defense. Each vessel carries Standard Missiles (SM-2) and Evolved Sea Sparrow Missiles (ESSM) in their MK 41 VLS. The Air Defense Coordinator uses the SM-2 missiles to engage the Chinese anti-ship missiles at

long-range. The cruiser and two destroyers fire nearly all of their SM-2 missiles and destroy 73 of the 80 inbound anti-ship missiles. Each ship uses ESSM, Close-in-Weapons-System (CIWS), chaff, and electronic counter-measures to destroy the seven remaining missiles. The strike group survived its first engagement with no losses.

Unfortunately, moments after the euphoria of survival subsides, the strike group commander realizes that they face a significant dilemma. While having won a tactical victory, the strike group suffered an operational defeat. The Chinese attack forced the strike group commander to decide whether to press forward, with only a few SM-2 missiles left for area defense against further ASCM attacks, to conduct a retaliatory attack or withdraw and rearm the strike group's escort ships.

The strike group commander ponders the similarities of their position and that of Rear Admiral Frank Jack Fletcher, who led the aborted attempt to relieve Wake Island after the first Japanese attack in December 1941.¹ An oiler with limited speed slowed the advance of Rear Admiral Fletcher's Task Force 11. The delay allowed the Japanese to make a second, successful assault on Wake Island that resulted in its capture on December 23, 1941.² Rear Admiral Fletcher, on orders from Vice Admiral William S. Pye, acting Pacific Fleet Commander, aborted the relief operation once the Marine garrison on Wake Island reported that the Japanese had landed.³ The relief force was

¹ The Wake Island garrison withstood one attempt by the Japanese to land on the island on December 11, 1941. The Pacific Fleet organized a reinforcement expedition to deliver additional Marines, aircraft, and critical materiel to Wake. The relief expedition, accompanied by the carrier USS *Saratoga*, cruisers and destroyers was constrained in its speed of advance, as the destroyers did not have the range to reach Wake Island without refueling. The single oiler accompanying the task force was limited to 12 knots, further slowing the Task Force's advance. The Task Force 11 was within 24 hours sailing time away from Wake Island when the Japanese completed a second, successful landing on December 23, 1941.

² Samuel Eliot Morison, *History of United States Naval Operations in World War II*. Vol 3, *The Rising Sun in the Pacific, 1931 – April 1942*, (Boston: Little, Brown and Company, 1948), 242-243.

³ Ibid.

delayed in reaching Wake Island, as its destroyers required refueling before the final approach to the island. If the relief force had arrived at Wake Island without refueling, the destroyers would not have had enough fuel to fight the Japanese invasion fleet.

The contemporary Navy carrier strike group is in a similar position; its escorts are unable to replenish their vertical launch magazines at sea. If the strike group remains in the area, the Chinese may attack it again and overwhelm their defenses. Reluctantly, the strike group commander orders a change of course to return to Guam while hoping that the Chinese do not escalate this new conflict by conducting missile strikes against the island's port facilities. Were the Chinese to do so, the carrier strike group would retire to Hawaii for reload, and take it out of action for nearly three weeks.

The strike group commander reasoned that based on time, distance, and available VLS munitions inventory that returning to port to replenish the surface combatant munitions was the best choice to preserve his force for future operations. He wistfully hoped for another option that would permit his units to re-arm closer to the battlespace. If only there was an option to utilize an austere port or anchorage, re-arming with munitions carried by the CLF, an auxiliary tender, or delivered by airlift and loaded by a crane ship.

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Chapter 1: Problem Defined

The Navy has developed underway replenishment (UNREP) operations that support fuel, provisions, materiel, surface gun ordnance, and aviation ordnance sustainment. These procedures were developed and perfected over the last century. The MK 41 VLS is a relatively new weapon system, first deployed on the USS *Bunker Hill* (CG 52) in 1986.¹ Due to its versatility in accommodating different types of missiles, 12 additional countries adopted the MK 41 VLS for use by their navies as well.² However, the vertical storage of missiles within the MK 41 VLS complicated its replenishment, as it did not fit within the routine delivery of palletized provisions, materiel, and ordnance via UNREP.

Loading a VLS cell is an exacting task. Missiles for the MK 41 VLS, packaged in a long rectangular canister, must be loaded vertically into launch cells (figure 1). VLS canisters exceed 20 feet in length and can weigh over 2,000 pounds, depending upon the weapon type. The original MK 41 VLS design specification included a requirement to load 10 SM-2 canisters per hour during an



Figure 1. Loading a VLS canister on a destroyer.
<http://sealbeachchamber.org/wp-content/uploads/2015/09/GuidedMissileDestroyerLoadingSBNWS.jpg>

¹ E. R. Huntoon (ed), *Jane's Naval Weapons Systems*, (London, UK: Jane's Information Group Limited, Sentinel House, 2000), 476-477.

² Kris Osborn, "Navy Upgrades Vertical Launch Systems." DEFENSETECH. <https://www.defensetech.org/2014/07/02/navy-upgrades-vertical-launch-systems/> (accessed February 28, 2017). The following countries use the MK 41 VLS: Australia, Canada, Denmark, Germany, Japan, The Netherlands, Norway, Spain, Thailand, Turkey, New Zealand.

UNREP, day or night, in Sea-State 5 conditions.³ A folding knuckle crane was included in the MK 41 VLS, but occupied space for three missile cells.⁴ The Navy found that moderate wind and wave action in Sea-State 3 caused excessive pendulum action with the crane and the canister and endangered the canister, VLS cell, and loading crew as well as restricted the loading rate to only three SM-2 canisters per hour.⁵ The Navy ceased loading operations with the MK 41



Figure 2. VLS Knuckle Crane
VIRIN: 020805-N-XP218-008 US Navy

VLS knuckle crane due to the hazards encountered when operating the knuckle crane at sea (figure 2). However, developing an underway MK 41 VLS rearming capability is only a partial solution to the larger problem of logistics sustainment of naval combat operations in the Western Pacific Ocean.

³ Marvin Miller, UNREP System Modernization, presented April 8, 2009, American Society of Naval Engineers Symposium, accessed October 11, 2016, <http://navalengineers.net/Proceedings/AD09/Papers/UnrepSystemModernizationFinalR1R.pdf>; Sea State is determined from the Beaufort Scale. Sea State ties together wind and wave action to describe ocean conditions. State 5 describes conditions of a fresh breeze, between 17 and 21 knots and moderate waves of approximately six feet.

https://www.ncdc.noaa.gov/sites/default/files/attachments/Marine_Beaufort_Scale.pdf, (accessed February 4, 2017).

⁴ Norman Friedman, *The Naval Institute Guide to World Naval Weapons Systems 1997-1998*, (Annapolis, MD: Naval Institute Press, 1997), 420.

⁵ The Standard Missile is the Navy's multi-purpose surface-to-air and surface-to-surface missile used on cruisers and destroyers. Sea-State 3 describes conditions of a gentle breeze between 7 and 10 knots and wavelets approximately two feet in height with breaking crests. https://www.ncdc.noaa.gov/sites/default/files/attachments/Marine_Beaufort_Scale.pdf, (accessed February 4, 2017).

Logistics sustainment of multiple USN carrier strike groups, amphibious groups, surface action groups, and submarines during combat operations require many different types and number of CLF vessels. While performing operations in the rear or along the edge of the maritime battlespace, the CLF may endure the threat of submarine and air attack, depending upon the capability of the adversary.

In the Western Pacific, USN strike groups and

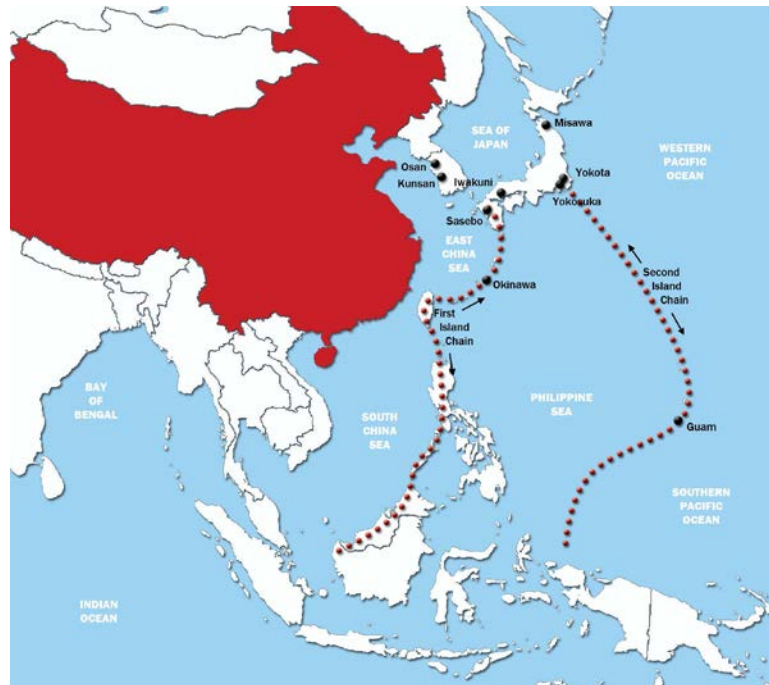


Figure 3. First and Second Island Chains

<https://cofda.files.wordpress.com/2013/12/1st-and-2nd-island-chains.jpg>

their supporting CLF depend upon forward bases that fall within China's First and Second Island Chain defense zones (figure 3).⁶ The Navy faces similar vulnerabilities from other potential adversaries around the world. Ports used as logistics hubs are likely targets as striking them would diminish the Navy's ability to sustain combat operations at the beginning of a conflict. The Navy depends upon the capabilities of the Joint Force to defend these advanced bases from conventional and asymmetric attack. Furthermore, foreign partners in key locations that have port facilities the Navy requires for logistics operations may be vulnerable to diplomatic and military threats of U.S. adversaries.

⁶ Andrew S. Erickson and Joel Wuthnow. 2016. "Barriers, Springboards and Benchmarks: China Conceptualizes the Pacific 'Island Chains'." *China Quarterly* no. 225: 1-22. *EconLit*, EBSCOhost (accessed February 3, 2017).

These partners may deny the U.S. access to their facilities. A situation such as this would require the Navy to seek other options that may complicate force sustainment.

There is historical precedence for diplomatic access denial that has affected U.S. military operations. France denied the U.S. overflight through its territory when it struck Libya in retaliation for a terror attack in 1986. In 2003, Turkey refused to permit U.S. ground forces to invade Iraq from its territory. The Chinese government may also exert diplomatic pressure and military threats on countries in the Western Pacific Ocean area, such as Singapore and the Philippines, encouraging them to deny the U.S. access for logistics operations.

Another weakness is the size and composition of the Navy's CLF. Presently, the CLF is only configured to sustain operations in a permissive maritime environment. The CLF has no excess capacity to sustain the strike force in the event of damage or loss of logistics vessels to enemy action. Additionally, an at sea or austere port reloading capability for the MK 41 VLS has never been tested in the crucible of combat. The Navy has not fought a sustained war at sea with a comparable naval power since World War II. With the absence of a near peer naval competitor after the demise of the former Soviet Union, development of equipment and procedures for reloading under combat conditions were not a priority. The Falklands War, (1982) between the United Kingdom and Argentina, is the most recent sustained naval conflict fought between two comparable powers. The Argentines used limited numbers of ASCMs during the war but the Royal Navy did not fire a significant number of surface-to-air missiles in warding off air and ASCM attacks. Furthermore, the naval missile launchers employed were rail and box type launchers with different reloading procedures than the MK 41 VLS, which had not

yet been deployed on a warship. Nevertheless, there are likely parallels between the Falklands and a potential war between the U.S. and China.⁷

Like the Royal Navy in the Falklands War, the U.S. Navy will operate at the end of a long logistics chain in the event of a prolonged conflict. The PLAN and PLAAF have the capability to interdict the U.S. sea lines of communication. In contrast, the Argentinian Navy and Air Force possessed insufficient forces and weapons that prevented them from intercepting Royal Navy ships. The U.S. forward bases in the Western Pacific, as well as agreements with key allies and partner nations, allow access to port and airfields that support logistics operations. However, possible Chinese diplomatic coercion or military action directed against the host countries could make these bases unusable.

The United Kingdom used Ascension Island as a staging base for transshipment but it was approximately 3,400 nautical miles from the operations area. The distance between Pearl Harbor, Hawaii, and Guam is approximately the same distance. While the Royal Navy's passage was uncontested between Ascension Island and the Falklands Island operations area, the U.S. Navy has no guarantee of uncontested passage between Hawaii and Guam. Vessels transiting the Pacific Ocean will be under threat of interdiction by PLAN submarines. The challenge for U.S. Pacific Command and the Navy is developing a flexible VLS munitions replenishment capability that provides a better alternative that minimizes time away from the operations area. Just as the carrier strike group commander lamented in the hypothetical vignette, as well as commanders

⁷ Christopher D. Yung, "Sinica Rules The Waves? The People's Liberation Army Navy's Power Projection And Anti-Access/Area Denial Lessons From The Falklands/Malvinas Conflict," In *Chinese Lessons from Other Peoples' Wars* (Carlisle, PA : Strategic Studies Institute, U.S. Army War College, 2011), 75.

throughout history, time lost to conduct sustainment operations equates to time that an adversary may use to gain the initiative.

Chapter 2: The Historical Context

“A sound logistic plan is the foundation upon which a war operation should be based. If the necessary minimum of logistic support cannot be given to the combatant forces involved, the operation may fail, or at best be only partially successful.”¹

--Admiral Raymond Spruance, USN

The current problem of sustaining modern naval combat in the Western Pacific Ocean is remarkably similar to the planning problems encountered by Army and Navy planners who developed and refined War Plan Orange, the operations plan for war with Japan.² Navy planners worked on this plan for nearly forty years, developing procedures for UNREP of fuel, provisions, materiel, and ordnance to sustain naval operations in distant waters, before its execution after Japan attacked Pearl Harbor. Planners face the same challenges now as they did prior to World War II. The U.S. has bases in the Western Pacific Ocean that are at risk of attack and long sea lines of communication to bases in Hawaii and the Continental United States. The Navy has a proficient CLF but lacks procedures for reloading surface combatant ship MK 41 VLS munitions away from established bases.

The Navy developed the current UNREP system through trials and operational requirements during wartime operations from the Spanish-American War to the Vietnam War. Initial efforts began with underway re-coaling operations to support blockade operations against the Spanish Navy in Cuba. The Navy transitioned from static operations in sheltered waters to underway re-coaling by the beginning of World War I. As the Navy transitioned from coal to oil during this period, it applied the same principle

¹ Worrall R Carter, *Beans, Bullets and Black Oil*, (Newport, RI: Naval War College Press, 1998), xxxi.

² Edward S. Miller, *War Plan ORANGE, The U.S. Strategy to Defeat Japan, 1897-1945*, (Annapolis, MD: Naval Institute Press, 1991), 65-76.

to refueling at sea, along with a shift from astern replenishment to alongside replenishment. This method was essential in deploying destroyers to Europe during World War I (figure 4).³ Alongside replenishment enabled greater speed and efficiency because the tanker could refuel two customer vessels simultaneously versus one using the astern method.

Operational necessity drove further innovation. Early versions of War Plan Orange called



Figure 4 USS Maumee (AO 2) refueling USS McCall (DD 28), May 28, 1917
<http://navylive.dodlive.mil/2014/05/28/navy-underway-replenishments-past-and-present/>

for the construction of a large, fortified base on Guam with facilities suitable for supporting capital ships and large numbers of destroyers and submarines.⁴ The Washington Naval Treaty (1922) ended further base construction in exchange for Japan's agreement to not to fortify their outlying islands as well.⁵ The removal of forward bases for fleet support spurred the development of the fleet train. The fleet train would sustain the battle force while construction battalions built logistics facilities on captured islands.⁶ By developing specialized vessels that could move forward with the fleet, the Navy

³ Marvin O. Miller, John W. Hammet and Terence P. Murphy, "The Development of the U.S. Navy Underway Replenishment Fleet," *Society of Naval Architects and Marine Engineers Transactions* Vol 95, (1987): 123-158.

<http://www.sname.org/HigherLogic/System/DownloadDocumentFile.ashx?DocumentFileKey=f44b637e-c251-4e00-9460-f1cc2f9a1d1b> (accessed September 8, 2016).

⁴ Miller, *War Plan ORANGE*, 74-75.

⁵ Ibid., 75.

⁶ Carter, *Beans, Bullets and Black Oil*, 4-5; The Fleet Train consisted of oilers, tenders, munitions ships, cargo ships, hospital ships, floating dry docks and myriad other auxiliary craft.

would not need to construct extensive shore facilities, which made it less dependent upon fixed bases.

At the beginning of World War II, fuel was the only commodity transferred at sea. The Navy still depended upon forward shore bases to sustain the fleet. Operations and logistic planners developed an operating concept for modular bases on an island atoll where supply ships, auxiliary tender vessels, and floating dry docks provided materiel delivery, repair, and other sustainment services within the atoll's protected anchorage.⁷ Supply ships transferred other commodities, including ammunition to customer ships while at anchor in protected waters. Typically, the supply ships delivered materiel via lighter or other small craft.⁸ This practice was sufficient in the early stages of the war in the Pacific, but as U.S. forces advanced on the Japanese home islands in the last year of the war, the carrier strike groups withdrew to replenish munitions and materiel at forward logistics sites located in various atoll anchorages.

The forward logistic base established on the Ulithi Atoll is the best example of this advanced base concept. It served as the hub for mobile logistic squadron operations during the last year of the war. Ulithi was the westernmost atoll in the Caroline Islands. The atoll, comprised of roughly 30 small islands, possessed a large anchorage, roughly 200 square miles in size with an average depth of over 80 feet. Adding to the utility of the large anchorage, Navy Construction Battalions built temporary piers, an airstrip, and other facilities to support the logistics base and its customers. Ulithi became an advanced logistics support site, served as a major fleet anchorage and staging base that sustained

⁷ Edward S. Miller, *War Plan ORANGE*, 75-76.

⁸ Carter, *Beans, Bullets and Black Oil*, 152.

naval strikes against Japan in 1945 as well as the invasions of Iwo Jima and Okinawa.⁹

Logistics operations conducted at Ulithi were the key factor in sustaining combat operations in the final year of World War II. The vast anchorage and the array of logistics and auxiliary vessels stationed at Ulithi advanced the concept of using it as a logistics hub to sustain combat operations that minimized requirements for vessels to return to Hawaii or the continental U.S. for repair except in the rare circumstance the scope of service required exceeded auxiliary vessel industrial capability.

Preparations for the invasion of Iwo Jima led to further discussions on how to provide additional logistics support in forward operations areas. Vice Admiral William Calhoun recommended the formation of a combat logistic support squadron to sustain the fleet at sea for extended periods.¹⁰ Author Thomas Wildenberg notes that the “formation of a logistics support group capable of providing all of the fleet’s logistic needs at sea was a natural extension of the development of fueling at sea.”¹¹ The logistic support group (Service Squadron SIX), enabled the carrier groups of Task Force 58 to remain on station, conducting sustained strikes against Japan.¹² After completing combat operations, the carrier groups would sail away from the operations area overnight and rendezvous with the logistic support group the next morning. The strike group would spend the entire day conducting UNREP operations, with each vessel going alongside oilers, munitions ships, general cargo ships, and refrigerated stores ships. Once the strike group completed UNREP operations, it would steam back to the operations area and

⁹ Anthony W. Gray, Jr., *The Big “L,” American Logistics in World War II*, ed. Alan Gropman (Washington, DC: National Defense University Press, 1997), 334-335.

¹⁰ Thomas Wildenberg, *Grey Steel and Black Oil, Fast Tankers and Replenishment at Sea in the U.S. Navy, 1912-1995*, (Annapolis, MD: Naval Institute Press, 1996), 197

<http://www.ibiblio.org/hyperwar/USN/GSBO/index.html> (Accessed December 21, 2016)

¹¹ Ibid.

¹² Carter, *Beans, Bullets and Black Oil*, 355-356.

resume combat the next morning. Two days of combat operations required roughly 36 hours away from station to refuel and rearm in order to resume operations. While this was a time consuming process in its own right, it was a significant improvement on the earlier practice of interrupting operations for as many as 12 days to replenish supplies.¹³ Conducting these logistics operations required the carriers groups to withdraw out of range of Japanese forces, which reduced the likelihood of attack. Additionally, the Navy still had to maintain sea control of the logistics area in order to minimize the possibility of submarine attack. Success depended upon balancing the distance required to minimize further enemy attack with the requirement to quickly resume combat operations upon completing the UNREP.

The Navy developed the fleet train concept with specialized ships carrying one commodity type (oilers, dry cargo, refrigerated stores, and munitions) for delivery to customer vessels. When customer vessels rendezvoused with the replenishment group, each ship would have to complete a separate UNREP with a delivery ship for each commodity needed. While the Navy demonstrated that afloat sustainment was practical, customer ships still had to conduct a separate UNREP for each materiel commodity required. A customer vessel requiring fuel, provisions, munitions, and general stores had to conduct as many as four separate UNREPs with four different ships. Further innovation was required to improve logistics efficiency and minimize the time required for UNREP operations. The next logical step was the development of a multiple commodity vessel, permitting combatant ships to obtain needed materiel during one UNREP.

¹³ Wildenberg, *Grey Steel and Black Oil*, 207

The next period of naval logistics innovation occurred during the Korean War. Carrier strike groups provided desperately needed close air support during the opening days of the war. While the Navy conducted operations in the Sea of Japan with close access to shore based support, the tempo of combat operations required the strike group to remain on station for long periods and highlighted the need for continued refinement of the munitions UNREP procedures developed during World War II. Carrier strike groups typically conducted UNREP operations every four days for fuel and munitions. However, transferring munitions proved especially difficult, as the USN had not improved munitions transfer capability after the end of World War II. Furthermore, the munitions ships were not designed to deliver weapons via UNREP. The vessels had insufficient crew and equipment to simultaneously break out munitions from the cargo holds, move them up to the deck, and then transfer them to the customer vessel.¹⁴ In order to sustain combat operations, the Navy needed ships that had the capability to stow, move, stage, and deliver materiel to customer combatant ships.¹⁵ The ideal vessel was a multiple commodity ship able to deliver all needed materiel during one UNREP.

After World War II, the Chief of Naval Operations, Fleet Admiral Chester Nimitz, proposed the construction of high-speed oilers and multiple commodity cargo ships to improve UNREP efficiency. This project did not advance beyond the concept stage but it did lead to further concept development with the acquisition and conversion

¹⁴ Miller, Hammet and Murphy, "The Development of the U.S. Navy Underway Replenishment Fleet"

¹⁵ Stow, move, and stage. This term refers to the sequence of building a customer order. Bulk materiel is stored in a cargo hold. Upon receipt of a customer order, the CLF vessel crew "builds" the order, marking it for delivery and then segregating it within the cargo hold. As space permits, along with safety requirements, the materiel is often moved to the main deck in advance of the UNREP to facilitate rapid delivery. This minimizes time spent moving customer materiel from the cargo hold to the transfer stations on the main deck of the delivery CLF vessel.

of an ex-German tanker used by the Kriegsmarine during World War II.¹⁶ The Navy converted the *Dithmarschen* and commissioned her as the USS *Conecuh* in 1953, a multi-commodity vessel, carrying fuel, munitions, refrigerated and general stores.¹⁷ The *Conecuh* operated as a multiple commodity ship, supporting exercises in the North Atlantic and the Mediterranean Sea during 1953 and 1954. The multiple commodity concept was very successful and led to a shift in procedure whereby tankers and cargo ships delivered their cargo to *Conecuh* for consolidation and final delivery to customer ships.¹⁸ The Navy extended the multiple commodity vessel concept across the CLF. It built specialized vessels and retrofitted single commodity vessels with materiel and fueling capabilities for oilers and stores ships, respectively. The *Conecuh* proved the value of the multiple commodity concept and demonstrated improved UNREP efficiency.

In 1957, Admiral Arleigh Burke, Chief of Naval Operations convened a conference of senior naval officers to review the capabilities of CLF ships and equipment. Admiral Burke cited his experience in World War II, and noted that time spent “replenishing was time lost in combat.”¹⁹ Adding emphasis to his World War II experiences, he linked them to challenges encountered during the Korean War and described a future vision for improved CLF vessels that traveled faster, had greater capacity to store more fuel and materiel and deliver it more quickly and efficiently.²⁰ Drawing upon lessons learned from World War II, the Korean War, and the USS *Conecuh*, the Navy designed and built the *Sacramento* class. Additionally, the Navy built

¹⁶ Wildenberg, *Grey Steel and Black Oil*, 208

¹⁷ Ibid.

¹⁸ Miller, Hammet and Murphy, “The Development of the U.S. Navy Underway Replenishment Fleet”

¹⁹ Ibid.

²⁰ Ibid.

or modified other classes of CLF vessels, which gave them multiple commodity functionality, able to deliver fuel as well as stores. However, only the *Sacramento* class and subsequent *Wichita*, *Supply*, and *Lewis and Clark* class vessels had full multiple product capability that included munitions.

With the demise of the former Soviet Union at the end of the Cold War, the Navy did not have to plan for sustained combat operations against a comparable naval power. At the end of the Cold War, the Navy possessed 11 multiple commodity vessels (*Sacramento* class and *Wichita* class) that could keep pace with carrier strike groups at speeds over 20 knots. An additional four ships of the *Supply* class were under construction to replace ships that were reaching the end of their useful service lives. Furthermore, the Navy had 21 tenders and other repair ships, which provided essential maintenance services for combatant ships as well as carrying limited stocks of sustainment materiel, including munitions.²¹ However, the Navy chose to decommission many of these vessels due to declining budgets and the excessive costs of maintaining a forward deployed logistics capability with no apparent near peer competitor. By the end of 2005, only four *Supply* class fast multiple commodity vessels and two submarine tenders remained in the fleet.²² Fiscal austerity and decisions to spend limited shipbuilding funds on combatant vessels increased the Navy's dependence upon forward bases to provide logistics support that had once been largely provided by the CLF and tender ships.

²¹ Richard Sharpe (ed), *Jane's Fighting Ships 1992-1993*, (London, UK: Butler and Tanner Ltd, 1992), 774-778

²² USS *Emory S. Land* (AS 39) based in Diego Garcia, supporting FIFTH and SEVENTH Fleet and USS *Frank Cable* (AS 40) based in Guam, supporting SEVENTH Fleet.

This section summarizes the development of the Navy's advanced logistics bases and UNREP capabilities during World War II. Advanced logistics bases were essential for fleet sustainment. During World War II, the Navy built advanced bases at numerous locations in the Pacific to support offensive operations, of which, Ulithi Atoll is the largest and best example. War Planners envisioned their need and incorporated the required capabilities for base development as well as acquisition of the many types of logistics vessels to sustain naval combat operations. The logistics vessels were essential as they provided operational flexibility, which allowed the Navy to move sustainment functions forward and support the fleet's advance. These vessels also minimized the need to build large port facilities ashore and provided the agility to follow the fleet. Further refinement of logistics ship capabilities led to the creation of the fast multiple commodity vessel that proved essential to supporting carrier strike group operations from the Vietnam War to the present day.

The Navy may apply the same concepts developed for supporting fleet operations in the last century to mitigate the challenges of rearming the MK 41 VLS away from established bases. VLS rearming requires cranes, a stable sea state, and specially trained loading crews. Adding these resources to existing logistics vessel capabilities or redesigning legacy tender ships may provide operational agility to sustain future operations. Vessels carrying VLS munitions stocks, with loading equipment and crews can follow the fleet and operate from austere ports or protected anchorages along the edge of the operations area. This agility may lessen the requirement for the Joint Force to provide dedicated force protection and transportation services to sustain naval combat operations.

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Chapter 3: How China May Exploit This Vulnerability

The Chinese view the Falklands War as a template for strategic access denial, using military power to hold external forces outside the East Asian littoral.¹ While Argentina lacked sufficient air and naval forces armed with anti-ship missiles to deny the British Royal Navy use of the Falklands operations area, China, during the last 30 years, has developed weapons systems to overwhelm forces attempting to contest its control of the East and South China Seas.² Furthermore, it developed the capability to strike U.S. forces and bases to limit the flow of deploying units or severely disrupt their operations, preventing them from exercising sea and air dominance.

China, unburdened by a large number of legacy naval systems, like the U.S., seized technical advances and constructed a modern naval force, and, to compensate for its smaller size, developed a defense strategy, which integrated sea denial capabilities across its armed forces. Captain Wayne Hughes discusses two trends in the evolution of naval warfare. First, the increased range of land to sea threats.³ Guided missiles, both ballistic and cruise, possess increased range and accuracy due improvements in design, manufacturing, and guidance systems. Combatant ships are increasingly vulnerable to either type of missile attack, especially when combined in sustained volleys that can overwhelm their defensive armament.⁴ Second, the trend of growing claims to ocean

¹ Lyle Goldstein, "China's Falklands Lessons," *Survival* 50, no. 3 (June 2008): 65-82, *International Security & Counter Terrorism Reference Center*, EBSCOhost (accessed October 11, 2016).

² Yung, "Sinica Rules The Waves?," 92-93.

³ Wayne P. Hughes Jr, "Naval Operations, A Close Look at the Operational Level of War at Sea," *Naval War College Review* 65, no. 3 (Summer 2012): 22-46, *Academic Search Premier*, EBSCOhost (accessed October 11, 2016).

⁴ Dennis M. Gormley, Andrew S. Erickson, and Jingdong Yuan, *A Low-Visibility Force Multiplier, Assessing China's Cruise Missile Ambitions*, (Washington, D.C.: National Defense University Press, 2014), 77.

ownership.⁵ China's Nine-Dash Line (figure 5) claim of virtually all of the South China Sea is an example of the trend, which theoretically restricts foreign military activities

within its claimed exclusive economic zone, in spite of the United Nations Convention on the Law of the Sea.⁶ In recent years, China has become increasingly forceful in defending its claims to the South China Sea by building military outposts on disputed shoals, harassing fishing vessels from other countries in the region, and



Figure 5. Nine-Dash Line
https://www.stratfor.com/sites/default/files/main/images/china_ninedash_line.jpg

observing and occasionally disrupting U.S. military operations within the area. These actions may lead to conflict between the U.S. and China.

The U.S. Navy fought a comparable naval power since 1945⁷ In all major conflicts and operations since the end of World War II, it has projected combat power ashore from a safe sea sanctuary. With few exceptions, the Navy's doctrine, training, and

⁵ Hughes, "Naval Operations."

⁶ Jonathan G Odom, "What Does a "Pivot" or "Rebalance" Look Like? Elements of the U.S. Strategic Turn Towards Security in the Asia-Pacific Region and Its Waters." *Asian-Pacific Law & Policy Journal* 14, No. 1 (April 2013): 1-32. <https://web.b.ebscohost.com/ehost/pdfviewer/pdfviewer?sid=f53e5453-50f4-47e3-a70b-acc4a1667eab%40sessionmgr102&vid=9&hid=128> (accessed February 4, 2017).

⁷ Hughes, "Naval Operations."

preparation for fighting in missile combat have been based vicariously on the experiences of other navies.⁸ The Navy developed the Aegis weapons system to defeat the Soviet Union's ASCM threat, but it has not been subjected to actual combat characterized by a massed attack.⁹ Accordingly, naval planners developed procedures for VLS replenishment and used them to rearm surface combatants with Tomahawk missiles. However, these VLS replenishment operations were conducted in forward bases that were immune from likely adversary attack.

The U.S. has fewer bases than a generation ago and these bases are not hardened to withstand attack. In the event of a U.S./China war, many nations in the Asia-Pacific region are likely to be susceptible to Chinese diplomatic and military coercion as they consider granting the U.S. access to key air bases and port facilities. Growth of Chinese power changed the political and military landscape. China has military dominance over the regional powers in the Western Pacific and significant political influence that may deter them from siding with the United States in the event of brief military conflicts.

China also has the advantage of operating along interior lines in the Western Pacific. Some military analysts consider the First Island Chain a Chinese maritime bastion because China can dominate the sea and air space and overwhelm U.S. forces that attempt to operate in this zone during conflict. China has an operational advantage as it has optimized the PLAN to fight in its home waters.¹⁰ Utilizing interior lines of communication and layered defenses, China can sortie naval and air forces to contest

⁸ Hughes, "Naval Operations."

⁹ Robert C. Rubel, "Connecting The Dots, Capital Ships, the Littoral, Command of the Sea, and the World Order." *Naval War College Review*, Vol 68, no. 3(Autumn 2015): 46-62.

¹⁰ Andrew Krepinevich, *Maritime Warfare in a Mature Precision Strike Regime*, (Washington, DC: Center for Strategic and Budgetary Assessments, 2014), 85, <http://csbaonline.org/uploads/documents/MMPSR-Web.pdf> (accessed December 28, 2016)

U.S. presence and then withdraw, conduct sustainment operations in protected ports and airfields, and then engage in further combat as required.

The area between the first and second island chains may effectively become a maritime no man's land in which China, using its long-range scouting and intelligence, surveillance, and reconnaissance (ISR) assets, can employ precision strike assets to deny the Navy freedom to maneuver.¹¹ The Navy and Air Force, operating from bases in Japan and Guam, can contest Chinese naval operations as well. However, China has the positional advantage as it can hold U.S. bases in Singapore, Japan, and Guam at risk and contest operations at air bases and naval ports with long-range strikes. Chinese war aims will determine whether it chooses to widen the war by striking U.S. bases in Japan and elsewhere. In the absence of hardened bases or destroyed facilities, the U.S. will require the ability to conduct logistics operations at points distributed along the outer edge of Chinese operational reach in order to sustain operations. Mobile logistics forces, operating from austere ports, or secluded anchorages will permit the Navy to conduct VLS rearming close to the operations area.

A naval war with China may be similar to what the Navy's Asiatic Fleet experienced during the first several months of the Pacific War.¹² The Japanese destroyed the U.S. Army Air Force units in the Philippines on December 8, 1941. After gaining air superiority over the main Philippine island of Luzon, the Japanese proceeded to bomb the U.S. naval base at Cavite, destroying virtually all of the supplies located there. Only the presence of a submarine tender preserved a modest ability for the Asiatic Fleet to sustain

¹¹ Krepinevich, *Maritime Warfare in a Mature Precision Strike Regime*, 97.

¹² Hunter Stires, "1941 Asiatic Fleet Offers Strategic Lessons," *United States Naval Institute Proceedings* 142, no. 8 (08, 2016): 58-63

combat operations. The remaining auxiliary vessels had to relocate to bases further south in order to avoid Japanese attack.¹³ Guam has the same vulnerability. Additionally, the Navy has only two submarine tenders, one operates from Guam and the other from Diego Garcia. If the Guam based vessel survived an attack, it would have to relocate further east or south, outside of the maritime no man's land in order to continue fleet support operations. Instead of retiring to Hawaii or Australia, the tenders may best serve the fleet by operating from protected atoll anchorages in the Western Pacific Ocean, outside the range of likely Chinese attack, but still close to the operations area. Employing the tenders in this manner would be reminiscent of Ulithi Atoll advanced base operations discussed previously.

China has continued to improve the capability of its armed forces to contest U.S. presence within the First and Second Island Chains. The PLAAF and PLAN have the capability to challenge U.S. surface and air operations within this area as well as conduct submarine operations against the USN. Additionally, with its long-range strike assets, it can strike naval forces between the First and Second island chains. However, the PLA depends upon effective and timely reconnaissance information to conduct strikes against naval forces operating in this area. China must seize the initiative at the beginning of combat operations by disputing the Navy's ability to maintain sea control between the First and Second Island Chains. Striking bases in Guam and striking or threatening to strike bases in Singapore and Japan have the potential to disrupt U.S. naval and air operations, which would limit the effectiveness of U.S. military action. To retain operational initiative, the U.S. must have a mobile forward base capability.

¹³ Stires, "1941 Asiatic Fleet Offers Strategic Lessons."

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Chapter 4: Implications for the Joint Force

The Navy relies upon access to foreign ports and overseas bases, which serve as logistics hubs for sustaining naval operations. This dependence upon foreign bases makes it vulnerable to rival nations possessing modern ASCMs combined with medium range ballistic missiles capable of striking its logistics hubs. The most obvious and immediate effects are damage to ports and supporting infrastructure required for VLS rearming operations or diplomatic pressure on host countries to deny U.S. access in the event of a conflict with a regional hegemon. In the Western Pacific, loss of access to facilities in Singapore, Guam, or Japan would require cruisers and destroyers to travel further south or east to Australia or Hawaii to replenish. In sustained operations, this would significantly slow naval offensive actions until the force was replenished and returned to the fight. Roughly calculated, a carrier strike group returning from Guam to Pearl Harbor, Hawaii, traveling at 25 knots would take at least 12 days to transit and return. This estimate does not include time for VLS loading or subsequent refueling at sea as the carrier strike group returns to the operations area.

If a naval conflict progresses beyond an initial engagement between the U.S. and China, the carrier strike group and other units entering the operations area will require replenishment of materiel and provisions. Similar to VLS rearming in port, replenishment also requires access to basing and commercial infrastructure of allies and partner nations in the Western Pacific. The Navy will have to airlift urgently needed materiel to ports where CLF units will load it along with provisions and fuel. The CLF units will then rendezvous with the carrier strike group to conduct an UNREP.

While CLF operations will be conducted outside of the maritime no man's land, they remain susceptible to interdiction. China can score a mission kill on a carrier strike group by targeting the limited number of CLF units with air and submarine forces. It may also bring diplomatic pressure to bear on other nations in the Western Pacific and encourage them to deny access to essential air and port facilities, which would complicate CLF operations.

To mitigate these threats, the Fleet Commander must consider two actions. First, he will have to detail surface combatants and maritime patrol aircraft to escort CLF units, patrol their operations areas, and protect them from attack. The loss of CLF units to adversary action would compromise force sustainment and the escort requirement would divert combat power from offensive operations.¹ Additionally, if China successfully influences neutral partners to deny the Navy access to ports and airbases, the CLF will have to travel further between the operations area and distant logistics hubs in order to sustain the force. More CLF units will be required to maintain timely delivery of critical materiel, thus increasing escort ship requirements and further siphoning combat power away, which could be used in offensive operations. These considerations resemble problems the Navy encountered in the Pacific Theater during World War II.

As noted previously, the Navy has operated in an uncontested maritime environment since the end of World War II. Schradly and Wadsworth note that the absence of conflict has colored the Navy's approach to planning naval operations.² Dr. Milan Vego echoes this theme as well, noting that while the U.S. is quite proficient in

¹ Milan Vego, "Modern Naval Logistics," *Naval Forces* 35, no. 4 (August 2014): 19-23. *Military & Government Collection*, EBSCOhost (accessed October 11, 2016).

² David Schradly and David Wadsworth, "Naval Combat Logistics Support System," *The Journal of the Operational Research Society*, 1991., 941, *JSTOR Journals*, EBSCOhost (accessed October 11, 2016).

executing naval engagements, it is unprepared to plan and execute sustained operations with the full spectrum of required logistics support.³ Furthermore, Vego assesses that future combat at sea will be short, intense, and result in heavy losses. Absent the ability to rearm VLS equipped vessels, the Fleet Commander will have to move his forces out of the operations area to rearm.⁴ The force capable of rearming its vessels close to the operational area and returning them to battle more quickly will retain the operational advantage. The lack of a VLS rearming capability away from established bases as a key shortfall requiring capability development as part of the Third Offset Strategy.⁵ The rearming of combatant VLS magazines is a logistics capability that the Navy has not required for the last 30 years, as it has not had to plan for sustained combat operations against a near peer adversary with modern naval forces and A2/AD weaponry.

The Navy's current force structure presents a challenge for the Joint Force Commander in executing the naval strike operations against a near peer adversary with substantial A2/AD capabilities. Military analysts who note the lack of ability to reload VLS munitions at sea, in austere ports, or anchorages have identified a symptom of the larger issue.⁶ However, the challenge can be met by utilizing selected vessels from the Military Sealift Command and Ready Reserve Force. Crane vessels could be fitted with new crane control technology that would mitigate the motion problems that complicate VLS reloading.⁷ Furthermore, a crane vessel operating in tandem with another vessel

³ Milan Vego, "On Major Naval Operations," *Naval War College Review* 60, no. 2 (Spring 2007): 94-126, *Academic Search Premier*, EBSCOhost (accessed October 11, 2016).

⁴ Vego, "Modern Naval Logistics," *Naval Forces*.

⁵ Timothy A. Walton, "Securing the Third Offset Strategy," *JFQ: Joint Force Quarterly* no. 82 (2016 3rd Quarter 2016): 6-15, *Military & Government Collection*, EBSCOhost (accessed October 11, 2016).

⁶ Vego, "Modern Naval Logistics," *Naval Forces*.

⁷ U.S. Department of the Navy, *Alternative Future Fleet Platform Architecture Study*, (October 27, 2016), by Navy Project Team, (Washington, 2016).

carrying stocks of VLS munitions would permit loading operations at austere ports or anchorages, which would provide greater agility in supporting combat operations.

The absence of a near peer naval competitor and constrained fiscal resources created an unbalanced force. Over the last 25 years, the Navy discarded its service force (submarine and destroyer tenders), reduced the size of its CLF, and eliminated 11 fast combat stores vessels that were dedicated to carrier strike group sustainment. The Navy did build four fast combat stores ships at the end of the Cold War (*Supply* class) but only two of these vessels remain in active service. Additionally, the size and capability of the CLF has been optimized for operations in an uncontested operations environment. In the intervening 25 years, the Navy has lost a generation of expertise in ship repair and auxiliary ship operations. While the decision to remove tenders and other auxiliaries from the active force was a fiscally sound short-term decision, it ultimately weakened the Navy by limiting its ability to sustain itself in forward operation areas when cut off from ports and airfields in partner and allied nations.

Sustaining Combat Operations

Adversary forces will launch ASCMs in large volleys in an attempt to overwhelm the target's ability to defend itself. Consequently, the ability of a carrier strike group to defend itself depends upon the ability of its air wing and surface combatant escorts to destroy adversary ASCMs and the platforms that carry them.⁸ The carrier strike group commander must apportion his aircraft to conduct strike operations while holding back a portion of the force to defend the strike group. If the combat air patrol cannot eliminate the adversary threat, the last line of defense is the surface combatant escort force.

⁸ ASCMs can be fired from surface ships, submarines, aircraft, and land-based missile batteries.

An adversary will attempt to overwhelm the carrier strike group with large numbers of ASCMs, forcing the escort ships to expend missiles at a rate greater than the actual number of ASCMs fired. The lack of an UNREP capability for the MK 41 VLS permits an adversary to achieve a mission kill even without scoring a hit.⁹ The carrier strike group will have to withdraw from the operations area to rearm in order to avoid a second attack with insufficient means to defend against it. The operational advantage goes to the force able to operate in close proximity to its logistics bases, which poses an inherent disadvantage for deployed naval forces, especially with vessels constrained in their ability to replenish munitions.

In October 2016, USS *Mason* fired two SM-2 missiles and one ESSM during an engagement against two anti-ship missiles.¹⁰ While details about the incident remain classified, open source news reports confirm the assumption that when engaging an air or cruise missile threat, the defending units will fire more missiles against the targets than their sum, which results in a high expenditure rate that can quickly deplete munition stocks during a massed attack.

At this time, sustaining naval combat operations with VLS weapons requires access to ports in order to reload the VLS cells. Additionally, the VLS weapons must be supplied from a forward storage magazine located nearby, a CLF munitions ship transferring munitions ashore for subsequent loading, or flown in to a nearby airfield by the U.S. Air Force Air Mobility Command and subsequent overland delivery to the port.

⁹ Norman Friedman, "RUNNING OUT OF AMMUNITION?," *Naval Forces* 33, no. 1 (February 2012): 8-13, *Military & Government Collection*, EBSCOhost (accessed October 11, 2016).

¹⁰ Sam LaGrone, "USS *Mason* Fired 3 Missiles to Defend From Yemen Cruise Missiles Attack," United States Naval Institute News, <https://news.usni.org/2016/10/11/uss-mason-fired-3-missiles-to-defend-from-yemen-cruise-missiles-attack> (accessed December 30, 2016)

Furthermore, the host nation and U.S. forces must protect this port facility from conventional and asymmetric attack. Conceptually, the host nation would provide force protection against asymmetric attack while U.S. forces provide defense against conventional air attack, using fighter aircraft and surface-to-air missile batteries based at sea or ashore.

Basing

The U.S. depends heavily upon access to forward bases, which is a key vulnerability against an opponent employing an A2/AD strategy.¹¹ Furthermore, adversary ballistic missiles threaten key facilities such as ports, munitions magazines, and warehouses.¹² In order to preserve a forward based sustainment capability, the U.S. should take measures to protect its forward bases. Critical base infrastructure should be hardened against direct attack. Additionally, the U.S. should expand the number of bases within the First, Second, and Third Island chains and harden them, using active and passive defensive measures, which would complicate adversary targeting.¹³ While expanding the capabilities of existing bases, the U.S. has also secured agreements for access and additional infrastructure support in Australia and Singapore.¹⁴ Access to these facilities in the Southwest Pacific provides the U.S. with more options sustaining military operations.

¹¹ William H. Ballard, Mark C. Harysch, Kevin J. Cole, and Byron S. Hall. "Operationalizing Air-Sea Battle in the Pacific," *Air & Space Power Journal* 29, no. 1 (January 2015): 20-47, *Academic Search Premier*, EBSCOhost (accessed October 11, 2016).

¹² Ibid.

¹³ Walton, "Securing the Third Offset Strategy." The Third Island chain refers to the line running from the Aleutian Islands, to Hawaii, to New Zealand, and Australia.

¹⁴ Mark E. Manyin, Stephen Daggett, Ben Dolven, Susan V. Lawrence, Michael F. Martin, Ronald O'Rourke, and Bruce Vaughn. 2012. "Pivot to the Pacific? The Obama Administration's "Rebalancing" Toward Asia." *Congressional Research Service: Issue Brief* 1-29. *International Security & Counter Terrorism Reference Center*, EBSCOhost (accessed February 16, 2017).

Munitions Procurement

Logistics and munitions planners should heed this fact now, reexamine expenditure rates per missile engagement doctrine, and lobby for additional funding to build munitions stockpiles. In order to sustain combat at sea, there must be sufficient stocks of VLS weapons. The problem is that no nation has fought a prolonged naval war using missile munitions against massed attacks so there is no historical data to use for extrapolation of likely expenditures. Tom Clancy and Larry Bond obliquely address the subject in their novel, *Red Storm Rising*. During a fictional Soviet Union attack on a carrier strike group, the escort ships expend their entire stock of surface to air missiles.¹⁵ The surface combatants noted in the novel preceded the deployment of the VLS. The MK 41 VLS has a larger missile capacity than the MK 13 and MK 26 systems that it replaced but potential adversaries may still overwhelm it with a large number of ASCMs.¹⁶

However, planners may draw some parallels from this example. A carrier strike group consisting of a carrier, cruiser and four destroyers has approximately 500 VLS cells across the five surface combatants. Within the VLS cells are varying numbers of Tomahawk, Standard (SM-2, SM-3, SM-6), Vertical Launch Anti-Submarine Rocket (VLA), and ESSM missiles. If the carrier strike group sails into the maritime no man's land, conducts a series of strikes against Chinese forces on land and sea, and engages in combat to fend off air, surface, and submarine attacks, it may expend up to 70% of the munitions carried in its VLS cells. Upon retiring from the operations area, the strike group would need to reload approximately 350 VLS cells across five surface combatants.

¹⁵ Tom Clancy, *Red Storm Rising*, (New York, NY: G.P. Putnam's Sons, 1986) 230-234

¹⁶ Friedman, *The Naval Institute Guide to World Naval Weapons Systems 1997-1998*, 420

While Tomahawk missile requirements are based on required targeting and past operational use, Standard missile expenditures as well as VLA and ESSM are a matter of conjecture. Operations and logistics planners must determine projected usage rates and develop stocking and transportation models to derive an optimum stock goal. Once the goal is set, it must be compared against current inventories and subsequent apportionment at oversea munitions stock points and ammunition supply ships. If additional missiles are required, the Navy must obtain additional procurement funding.

Lift

Using the example above for VLS munitions expenditure of one carrier strike group for a foray into the maritime no man's land to conduct strike operations, the Naval Component Commander has a requirement to move as many as 350 VLS weapons to a forward base for surface combatant munitions replenishment. Ideally, the munitions would already be pre-positioned at a magazine near a suitable port. Another alternative is carrying part or all of the VLS weapons on a multiple commodity CLF vessel such as a T-AKE.¹⁷ However, the munitions load carried by the T-AKE must support the carrier air wing as well as the escort ships. Positioning additional VLS munitions at sea may require additional munitions ships, which would also place them at risk of attack. At best, the strike group T-AKE may carry some of the VLS munitions. For this example, the T-AKE will carry 50 VLS missiles.

¹⁷ T-AKE – multiple commodity stores and munitions vessel. Carries provisions, materiel, ordnance, and fuel. Maximum speed 20 knots. A T-AKEs and an oiler (T-AO) operate as a pair to provide the same commodity range and depth for a carrier battlegroup as a T-AOE. The primary difference is that the T-AKE and T-AO maximum speed is 20 knots compared to 26 knots for the T-AOE.

This leaves a requirement to move 300 missiles from stock points in the United States to the rearming port. Depending upon the type of long-range cargo aircraft used, it will take approximately 17 sorties to deliver the VLS munitions to an airfield for subsequent delivery to the port for loading on the combatant or cross loading onto another vessel for delivery via mixed-mode transportation.¹⁸ For direct delivery to the surface combatant, the airfield must be capable of handling a C-5 or C-17 aircraft. If mixed mode transportation is required, a possible candidate is a *Spearhead* class expeditionary fast transport (figure 6).

However, this vessel would require changes in configuration as well as a waiver of safety regulations



Figure 6. USNS *Spearhead* (T-EPF 1)
<http://www.msc.navy.mil/annualreport/2014/images/140725-N-EW716-002.jpg>

to haul munitions.¹⁹ The utility of a high-speed transport modified to carry VLS munitions warrants further examination as it provides another means of quick movement between stock points and rearming points. If sufficient stocks are available from Hawaii, the fast transport could arrive at Guam in approximately five days, covering roughly 3,300 nautical miles at an average speed of 30 knots. Traveling from Seal Beach,

¹⁸ Mixed mode transportation is the use of air and sea assets to move materiel to a port of debarkation.

¹⁹ U.S. Department of Defense, Director, Operational Test and Evaluation, *FY 2009 Annual Report*, Washington, DC, 2009, 134. <http://www.dote.osd.mil/pub/reports/FY2009/> (accessed April 18, 2017).

California to Guam, approximately eight days would be required but this does not account for delay to conduct refueling at sea.

If the demand for VLS munitions exceeds the available inventory at a forward stock point (ashore or afloat), the best transportation mode for additional weapons may be mixed mode transportation, using a high-speed transport to move VLS canisters from a C-5/C-17 capable airfield co-located with a port. The VLS canisters would be loaded onto the high-speed transport for final delivery to the austere port or anchorage. Upon arrival, the QRT or tender would load the VLS canisters on the surface combatant. The challenge is to determine supporting requirements for operations beyond the first strike; this will determine the total lift requirement and the number of vessels required to sustain delivery of VLS missiles and aviation ordnance to the carrier strike group.

Chapter 5: Options to Improve VLS Reloading Capabilities

VLS reloading is a symptom of a larger problem in sustaining naval combat operations. Weapons system engineers included a self-reloading capability in the original MK 41 VLS design. However, the slow loading rate, along with instability induced by sea-state made the operation impractical and dangerous. Naval Sea Systems Command (NAVSEA) continued to examine new methods and equipment to mitigate the stability problems as well as increase the loading rates. However, the end of the Cold War, the absence of a near peer naval competitor, and reduced defense funding diverted attention from this issue.

Furthermore, the Navy changed its outlook on logistics sustainment. Destroyer and submarine tenders were decommissioned as a cost savings measure. Tenders proved essential during World War II and the Cold War for sustainment of deployed ships with maintenance and other logistics services. Additionally, tenders had cranes and munitions magazines, which provided a means to replenish missile magazines as well as to exchange missiles requiring maintenance. While the decommissioning of these vessels reduced fiscal expenditures and manning requirements, it also made the Navy more dependent upon access to foreign ports and shipyards to conduct emergent repairs. Additionally, the removal of tenders from the fleet made the Navy even more dependent upon access to foreign bases for repairs and materiel replenishment. Lastly, eliminating tenders from the fleet removed a practical afloat munitions stock point as well as the equipment and personnel required to conduct munitions replenishment.

Now, the Navy is dependent upon airlift of munitions, personnel, and equipment to carry out VLS replenishment. The Navy's current VLS reloading capabilities are

summarized in Table 1. Dependence upon airlift will divert limited inter-theater airlift resources in a crisis, potentially delaying the movement of other critically needed units and materiel required by the Joint Force to build combat power.

Current VLS Reloading Capabilities				
Capability	Crane	Loading Team	Munitions	Joint Enablers
Underway Replenishment	No <ul style="list-style-type: none"> Crane not installed or operable on combatant ship 	No <ul style="list-style-type: none"> Combatant ship crew not certified 	Yes <ul style="list-style-type: none"> Delivery by CLF 	Not required
Established Port or Forward Base	Yes	Yes <ul style="list-style-type: none"> Loading team assigned to base or QRT 	Yes <ul style="list-style-type: none"> Local munitions magazine Aerial delivery CLF delivery 	<ul style="list-style-type: none"> Aerial movement of munitions, QRT, and equipment Area air defense

Table 1

NAVSEA has continued to develop prototype methods and equipment for reloading VLS cells. Problems with load stability when performing the operation at sea and slow loading rates made the original design impractical. NAVSEA continued to study equipment modifications and techniques to improve VLS replenishment capability.¹ A new prototype for VLS replenishment developed by NAVSEA has a designed transfer and loading rate of 15 missiles per hour in Sea State 5 conditions (figure 7). This prototype includes a rearming device, powered by a hydraulic unit on the receiving ship. A three person

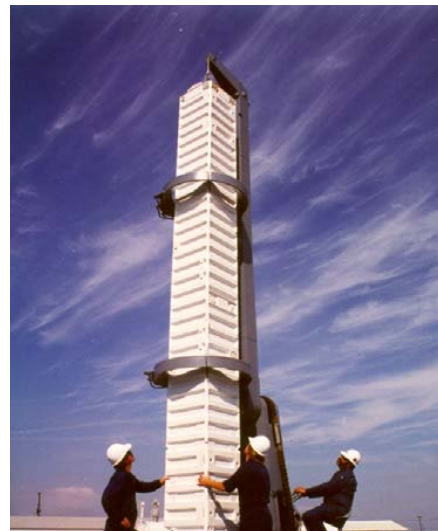


Figure 7 Prototype at sea VLS rearming device operated by a loading team from CLF vessel
Miller Underway Replenishment System Modernization

¹ Marvin Miller, "Faster, Safer, Heavier, More Reliable," *Sea Power* 45, no. 5 (May 2002): 43. *Military & Government Collection*, EBSCOhost (accessed October 11, 2016).

loading team from the delivery ship operates the device on the receiving ship. This rearming device has potential to solve the VLS at sea replenishment problem, but requires further testing, evaluation, and refinement.² However, additional factors complicate the problem of VLS replenishment:

- Surface combatants have limited deck space to stage canisters awaiting loading as well as moving expended canisters back to the delivery vessel for retrograde shipment
- Minimum of four hours of connected UNREP would be required to replenish the magazines of one vessel³
- Replenishment ship limited capacity to carry sufficient numbers and types of VLS munitions while still carrying sufficient stock of aviation ordnance for aircraft carrier

The most practical solution for rearming VLS munitions underway may be the ability to replenish or exchange small numbers of missiles quickly. Conducting a full VLS magazine replenishment underway is impractical due to the volume of missiles to be loaded, returning empty VLS missile canisters to the supply vessel, and time involved.⁴

Another approach to mitigate the VLS replenishment challenge and the larger issue of sustaining naval forces during an extended maritime operation is to revisit the

² Miller, “UNREP System Modernization”

³ Connected UNREP – CLF vessel and customer ship connected together with wire rope assemblies and hoses that permit transfer of materiel and fuel.

⁴ Munitions loading teams must maintain training certification to handle VLS canisters. An empty canister must be removed from the VLS cell before a new canister can be loaded. The empty canister can be refurbished to carry a new weapon. Additionally, the flow of empty canisters and full canisters would require careful management to prevent movement bottlenecks on the customer and supply vessel. Finally, on *Arleigh Burke* Class destroyers, Flight IIA and newer, VLS canisters would have to be lifted from the main deck in order to be loaded in the aft VLS launcher. This is another complicating factor that would require additional procedures and equipment to resolve.

concept of sea basing. The term “sea basing” is most commonly associated with amphibious warfare.⁵ However, sea basing is not simply the enabling of amphibious operations. The fleet train of tenders, oilers and other supply ships employed during World War II were a mobile sea base as it provided the logistics agility to sustain the fleet at sea and in anchorages along the periphery of the operations area.⁶ The Navy should also examine sea basing as a means of supporting the fleet with mobile logistics bases as it did during World War II.



Figure 8. USS Cole (DDG 67) alongside USS Emory S. Land (AS 39).
http://www.navy.mil/view_image.asp?id=13017

Crane ships, tenders, or CLF ships fitted with cranes could replenish surface combatants with VLS munitions while moored alongside in an austere port or anchorage (figure 8).

The Navy should also continue study and testing of advanced cranes that compensate for motion and would permit VLS replenishment operations to be conducted at anchor as well. Development and fielding of an advanced crane that mitigates swaying motion along the three axes of movement would give the Navy the ability to replenish VLS munitions at anchor. Combining an advanced crane with tenders and other support vessels or would permit the Navy to create a mobile sea based munitions stock point.

⁵ Sam J. Tangredi, “The Role of Sea Basing,” In *Rebalancing U.S. Forces Basing and Forward Presence in the Asia-Pacific*, (Annapolis: Naval Institute Press, 2014), 199-212.

⁶ Robert O. Work, *Thinking About Seabasing, All Ahead, Slow*, (Washington, DC: Center for Strategic and Budgetary Assessments, 2006), 9.

Additionally, adding tenders to the fleet merits review due to the maintenance, logistics, and other support services they may provide as well as the capability to store and load VLS munitions on surface combats.⁷ Tenders would serve as the centerpiece of a mobile sea base, restore agility to the fleet, and permit it to operate freely along the outer edge of the battlespace. This mobile sea base would consist of a crane ship and a munitions ship or a tender and a munitions ship. Urgent munitions not carried by the tender or munitions ship could be delivered by air or mixed mode transportation. The recommended future capabilities are summarized in Table 2.

Future VLS Reloading Capability Development				
Capability	Crane	Loading Team	Munitions	Joint Enablers
Underway Replenishment	Yes <ul style="list-style-type: none"> • UNREP loading rig provided by CLF 	Yes <ul style="list-style-type: none"> • Load team embarked on CLF, moves to customer vessel during UNREP 	Yes <ul style="list-style-type: none"> • Delivery by CLF 	Not required
Established Port or Forward Base	Yes <ul style="list-style-type: none"> • Obtained locally • Utilize tender capability 	Yes <ul style="list-style-type: none"> • Loading team assigned to base, QRT, or tender 	Yes <ul style="list-style-type: none"> • Local munitions magazine • Aerial delivery • CLF delivery • Tender 	<ul style="list-style-type: none"> • Aerial movement of munitions, QRT, and equipment • Area air defense
Austere Port	Yes <ul style="list-style-type: none"> • Utilize tender capability 	Yes <ul style="list-style-type: none"> • QRT • Utilize load team embarked on tender 	Yes <ul style="list-style-type: none"> • Aerial delivery • CLF delivery • Tender 	<ul style="list-style-type: none"> • Aerial movement of munitions, QRT, and equipment if tender not available
Anchorage	Yes <ul style="list-style-type: none"> • Provided by tender, crane ship, or other vessel 	Yes <ul style="list-style-type: none"> • Embarked on tender, crane ship, or other vessel 	Yes <ul style="list-style-type: none"> • CLF delivery 	<ul style="list-style-type: none"> • Potential requirement for area air defense

Table 2

⁷ Seth Cropsey, Bryan G. McGrath, and Timothy A. Walton, *Sharpening the Spear: The Carrier, the Joint Force, and High-End Conflict*, (Washington, DC: Hudson Institute, 2015), 78. Accessed February 18, 2017. <https://s3.amazonaws.com/media.hudson.org/files/publications/201510SharpeningtheSpearTheCarriertheJointForceandHighEndConflict.pdf>.

There is historical precedence for this. The Navy developed a forward logistics site at Ulithi Atoll during World War II, combining logistics vessels (tenders, cargo ships, oilers, floating dry docks) and temporary shore facilities to sustain operations against Japan during the last year of the war. Naval forces replenished at Ulithi and obtained repairs, allowing them to remain in close proximity to the operations area. Additionally, Ulithi served as a replenishment point for the Service Force (the forerunner of today's Combat Logistics Force), loading materiel on stores ships and refueling oilers before they made delivery runs to replenish the carrier strike groups. The carrier strike groups would only retire from the operations area to replenish munitions and obtain necessary repairs that were beyond the ability of the individual ships to conduct themselves.

Training: Logistics Plays a Greater Role in Operational Exercises

U.S. Pacific Command conducts several joint exercises annually. These exercises permit the Joint Force to practice the operational tactics, techniques, and procedures required execute wartime missions such as strike, maneuver, and deployment of additional forces. However, exercise planners frequently overlook operational logistics, simulating required actions such as VLS munitions reloading, in order to permit maximum operations during the exercise. Schrady and Wadsworth observe that “when combat logistics are not dealt with realistically, the real and important interactions between tactics and logistics are masked.”⁸ During warfighting scenarios, combatant ships have their munitions “constructively” rearmed due to the limited time available for training.⁹ This constructive rearming hides the tactical problems that a commander must resolve after an engagement. These tactical problems have real importance as they affect

⁸ Schrady and Wadsworth, "Naval Combat Logistics Support System."

⁹ Ibid.

the decision-making cycle of the carrier strike group commander and will force additional actions that may hinder future operations. Finally, the Geographic Combatant Commander may have to delay operations and employ forces from the other components differently than planned until the surface combatants complete their VLS munitions replenishment.

In order to understand fully the effort involved, the Navy and Geographic Combatant Commanders must practice VLS reloading as part of exercises, employing new loading equipment and techniques in an operational environment. The PLAN has conducted similar exercises; the U.S. Navy must do so as well.¹⁰ By training as it intends to fight, the Navy and the Joint Force as a whole can develop the tactics, techniques, and procedures needed to sustain naval combat power, minimize time required for logistics operations, and minimize the likelihood of ceding operational initiative to the enemy.

As the Navy improves its VLS rearming capabilities, it should test them during exercises. These exercises should be joint, as logistics operations along the edge of the operations area will require support from the Services for transportation, ballistic missile defense, air defense, force protection, and other logistics enabler units. These exercises should have the following elements:

- Loading VLS munitions at an austere port or anchorage in U.S. Pacific Territories and other islands in the Central and Western

¹⁰ Ben Blanchard, "China Navy Holds First Missile Combat Resupply Drill," *Reuters*, July 2, 2015, <http://www.reuters.com/article/2015/07/02/us-china-defence-drill-idUSKCN0PC19H20150702> (accessed January 2, 2017)

Pacific, which the U.S. has strategic access agreements with (figure 9)¹¹

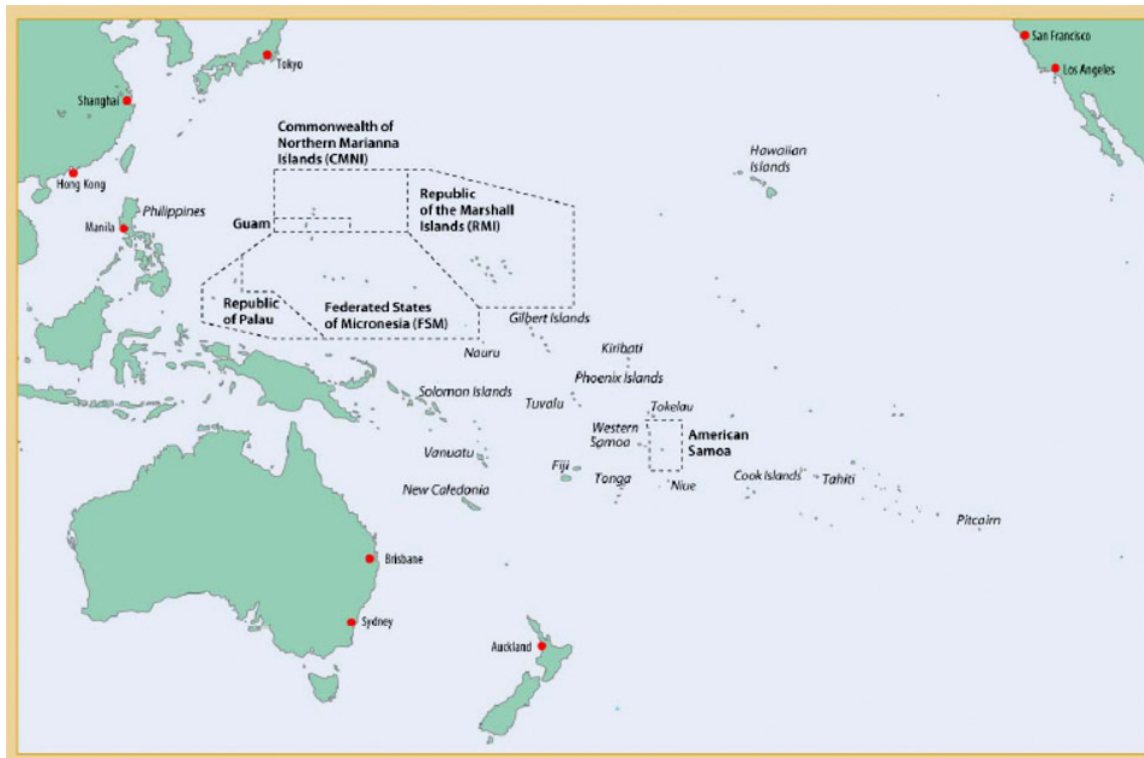


Figure 9 U.S. Pacific Island Territories and Island Nations with strategic access agreements
<http://www.pacificcancer.org/site-media/uspi-map-big.jpg>

- Simultaneous VLS replenishment of at least two vessels in an austere port or anchorage
- Drawing VLS munitions from afloat stocks and overseas pre-positioned storage
- Swapping VLS munitions between surface combatants in an austere port or anchorage

¹¹ U.S. Department of the Interior, “Office of Insular Affairs.” <https://www.doi.gov/oia> (accessed February 17, 2017). U.S. territories include American Samoa, Guam, and the Commonwealth of the Northern Mariana Islands. The U.S. also has agreements with the Federated States of Micronesia, the Republic of the Marshall Islands, and the Republic of Palau that permit unlimited and exclusive access to their land and waterways for strategic purposes.

- Inter-theater movement of key VLS munitions to a forward logistics hub and subsequent intra-theater movement to the loading site
- Movement of logistics units to facilitate cargo movement and final delivery to an austere port or anchorage
- Deploying force protection units to provide security at loading site
- Deploying sea and land based forces to provide Ballistic Missile and Air Defense capabilities at the loading site

By incorporating the elements above in exercises, the Joint Force Commander can prepare the force to sustain extended combat operations. Inclusion of VLS reloading in exercises may also improve interoperability with partner nations that use the MK 41 VLS as well. As noted by several sources, sustaining a naval war requires support from all the services as it encompasses air movement of critical munitions, providing force protection from local and long-range air or missile attack, and using unique service logistic capabilities for moving materiel within the theater. Just as the fight itself is joint, so too is the sustainment effort; no service can support itself without assistance from the others. Practicing joint logistics operations in peacetime fills in the gaps and seams that may disrupt coordination between the service components and Combatant Commanders during war. The Joint Force must practice realistic VLS reloading and training under difficult conditions to ensure it can sustain naval surface combatant operations.

Conclusion

The Navy has sacrificed its ability to sustain combat operations at sea due to conscious decisions based upon fiscal restraints imposed after the Cold War. Assuming away the threat of a near peer competitor, the Navy dismantled its afloat logistics forces, decommissioning nearly all tenders and canceled building programs for additional fast combat support ships.¹² Additionally, the Navy did not make development of a workable VLS rearming capability a high priority. Lack of an underway VLS replenishment capability has been a known issue for over 30 years but the absence of a near peer naval competitor diminished the urgency developing a solution. This fact, coupled with a lack of key auxiliary vessels, makes the Navy vulnerable to adversaries that seek to deny access to the Navy's current overseas bases through diplomatic pressure, military threats, or attack.

The failure to develop an ability to replenish VLS munitions in austere locations limits the Geographic Combatant Commanders' operational choices, forcing him to allocate lift and defense capabilities to regenerate naval combat power that could be more efficiently used for deployment of combat power. The Navy must develop a holistic approach to sea basing, supporting afloat forces as well as expeditionary forces. A modern sea basing capability must include rearmament, repair, and replenishment capabilities, like those used by the Navy in the Western Pacific during World War II.

Technical efforts are underway now to mitigate the VLS reloading issue. Improvements in equipment, techniques, and procedures must improve the current

¹² Norman Polmar, *The Naval Institute Guide to Ships and Aircraft of the U.S. Fleet*, (Annapolis: U.S. Naval Institute, 2005), 270. Program to build eight T-AOE(X) fast combat support ships during FY 2009-2033 canceled due to high cost.

capabilities and permit some limited reloading capability at sea. Adding tenders to the fleet may provide the most flexibility with maintenance, logistics services, and VLS rearming capability. Finally, the mobility of a tender permits it to follow the fleet as a mobile sea base, giving the fleet greater logistics agility.

The Navy needs senior leader sponsorship to advocate for funding and resolution of this issue. Past significant advances in the Navy's UNREP capabilities occurred when the Chief of Naval Operations took a personal interest in the issue and when operational necessity forced senior leader attention to solution development. The development of War Plan Orange led to the identification of the requirement for mobile advanced bases. Sustaining naval air strikes against Japan in the final year of World War II led to expedient procedures to transfer aviation ordnance at sea. Admirals Nimitz and Burke, drawing upon their World War II experiences, directed the testing of multiple commodity CLF vessels that resulted in the design and fielding of fast combatant stores ships capable of delivering fuel, munitions, and general stores to carrier strike groups. Without advocacy by senior operational commanders, these logistics capabilities would not have been developed.

The Navy and the Joint Force are experiencing a similar challenge. Rapid VLS rearming is required to sustain a naval war against China or any other naval near peer competitor. The Joint Force requires a VLS rearming capability in austere locations to mitigate likely A2/AD strategies that an adversary may employ against the modern ports and airbases that the U.S. currently depends upon for logistics sustainment. The Navy and the Joint Force must develop the equipment, techniques, and procedures to conducting limited rearming at sea and full rearming at anchor or in austere ports. While

the VLS rearming issue primarily affects the Navy, the Joint Force is affected as well as it provides additional resources for transportation, basing, force protection, and ballistic missile defense. The Chief of Naval Operations and the Geographic Combatant Commanders must advocate for the fiscal resources to solve the issue and then test the solutions in practical exercises and operations involving the Joint Force.

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